arbitrary choice of auction sequence in terms of frequency, geography, or relative order between single and combinatorial bids.

While some parties may object to simultaneous auctions on the grounds that they would be too complex to run or to participate in, we believe that these concerns are overstated.[3] As others have noted, the auctions could be kept open for a reasonably long period of time (say two weeks to a month) to insure that parties had sufficient time to process the bidding information that they were receiving. Moreover, the use of repeated sealed bids or electronic bidding may keep the administrative costs and complexity at relatively low levels.

Some may be concerned that small businesses or some other class of potential bidders may lack the resources to track simultaneous auctions. We think that such fears are misplaced for three reasons. One, a small business may be unlikely to wish to compete for more than a few of the individual licenses. Two, these bidders, like all others, may benefit from the information provided to them by the bidding for the other licenses. Third, we would expect to see firms offer bidding consulting services that would make the requisite expertise available to small businesses and other auction participants.

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3 One also needs to keep in mind the complexity of the sequential auction alternative. While sequential auctions may appear to be more straightforward, they require parties in early auctions to make sophisticated and potentially very complex forecasts of what is going to happen in the remaining auctions.

If the Commission remains concerned about the practicality of simultaneous auctions, it might initially run auctions for only a subset of the frequency blocks. The Commission could then evaluate the workings of the process before running the remaining auctions.

The main issue in the design of simultaneous auctions is how to construct a stopping rule. It is important to recognize, however, that this issue is not unique to simultaneous auctions. The choice of sequential auctions is essentially a choice of an arbitrary set of stopping rules.

There are three primary issues that arise in the design of a stopping rule.

1. What is the basis of the stopping rule? The stopping rule can be based on the flow level of bidding activity or a fixed time limit. Because of the difficulties with fixed-time stopping rules discussed in point 2 below, we recommend that the Commission adopt a stopping rule based on a set interval of time's passing without the submission of a new bid.[4] The Commission may also want to set some overall time limit to avoid having parties strategically delay the termination of the auction. Alternatively, the Commission may wish to retain sufficient discretion to make a later determination that the public interest is served by bringing the auction to a close on a specific date.

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4 In the case of a sealed bid auction with multiple rounds, the "time interval" would actually be a round of bidding.

We also note that, if a rule specifying termination "once bidding ceases" is adopted, it would be valuable to specify a minimum bid increment in order to prevent strategic bidding designed simply to prolong the auction. Such an increment could be either an absolute amount or a percentage of the current high bid. Given the uncertainty and the substantial variation in the likely bid amounts for different licenses, we favor the use of a percentage increment.

2. Is the stopping rule known to the bidders? If a fixed time limit is set and is known to the potential bidders, there may be well-known difficulties arising from the incentive for bidders to wait until just before the deadline before submitting their bids. If the Commission does adopt a fixed-time stopping rule, it may wish to keep the exact time secret from the bidders until it has expired. The use of a secret rule might, however, lead to claims of unfairness, increase the risk faced by bidders, and lead to inefficient outcomes.

3. Does the bidding for individual licenses stop independently or all at once? This issue arises because of the interdependence of true economic values (i.e., the desire to put together combinations of licenses) and because of limited bidder budgets. Both

of these factors result in a buyers' willingness to pay for one license being dependent on the cost of obtaining other licenses.

In instances where parties are attempting to aggregate licenses, attention must be paid to the issue of whether the stopping rule favors either bidders seeking individual licenses or bidder seeking to aggregate licenses. This issue arises whether or not explicit combinatorial bidding is allowed, but may be particularly controversial when there are explicit combinatorial bids because the divergence of different parties' interests will be starkly identified.

We recommend that the Commission simultaneously stop the bidding for all licenses being offered in a given round of auctions in order to put all bidders on equal footing when making their decisions whether to cease bidding. At the same time, we recognize that no stopping rule will be perfect.

While we strongly urge that the Commission adopt simultaneous auctions, in our comments we stated that, if the Commission does adopt sequential auctions, it should auction an entire spectrum block before proceeding to the next one, and it should randomize over the order in which geographic regions within a block are licensed.

This ordering has two advantages relative to other patterns of sequential auctions. Under this approach, bidders

for later blocks would have considerable information about the valuations implicit in prior blocks for specific geographic markets when determining their bids. Using a block-first, market-second ordering would also facilitate combination bids across geographic markets, which we believe will be the more important form of combination.

The order in which spectrum in different geographic areas is auctioned off can matter for both efficiency and fairness. Most of the proposals for specific orderings have focused on the population living in the license areas. Because information will be greater for later auctions, some have suggested that smaller licenses should be auctioned first. Others have argued that larger licenses are more critical for implementing combination strategies and thus these should be auctioned first. Without assessing the validity of these arguments, we simply note the lack of agreement. Moreover, we note that the choice of order may artificially increase the risks faced by a firm that feels compelled to bid in its home region, where that region has been selected to be auctioned early in the overall process. Therefore, if the Commission does adopt sequential auctions for different geographic areas, it should proceed in random order across trading areas within each block and should choose a different geographic ordering for each spectrum block. It is important to note, however, that even this proposal does not mitigate the efficiency losses inherent in sequential bidding.

B. Each License Should be Allocated Through the Use of an Auction with Iterative, Ascending Bids.

Under a single round of first-price sealed bidding, parties may bid strategically and make incorrect guesses about the bidding strategies of their rivals. As a result, spectrum may be inefficiently allocated. To limit such misallocations, it is important to give each party the chance to put in a higher bid if it values the spectrum by more than the current high bidder. This iterative bidding may be carried out electronically, through the use of paddles in an auction room, or through the submission of a series of sealed bids.[5]

The use of iterative bidding also provides a greater level of information than does one-time sealed bidding. When each firm is uncertain about the economic value of the spectrum, it may be able to learn something about its own valuation from the values that other potential service providers place on the spectrum. Under an iterative process, some of this information may be conveyed through the bids that are submitted. When a firm sees other bidders expressing a willingness to pay a high amount for the spectrum, that firm may raise its own estimation of spectrum value. For this reason, it may be useful for the Commission to adopt auction procedures that allow each bidder to see how many other bidders are still active at the prevailing

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5 For reasons given in our earlier comments, we believe that, whichever form is used, the bidders should not know one another's identity until after the bidding has ceased. There are procedures for insuring bidder anonymity that could be implemented for any of these choices of the physical process for submitting bids.

price. A Japanese auction, for example, is one institution with this feature.[6]

In comparison with the iterative process just described, one-round sealed bidding limits the learning process. Under sealed bidding, the firm that ends up being the winning bidder does not have a chance to see the actual value of the next-highest bid when choosing its own bid. Nor does a losing firm get to a chance to respond with a revised bid.

Under the proposals in the Notice of Proposed Rulemaking, this issue of one-round sealed bidding appears most likely to arise in the context of combinatorial bidding. If a single round of sealed bidding is used for combinatorial licenses, then the cost and risk of obtaining an MTA or national license can be significantly affected by a decision to allow sophisticated bids (e.g., a national license bid expressed as a premium over the sum of individual bids, subject to some upper limit or reservation price). The Commission should examine the use of this or some other generalization of a Vickrey auction. These generalizations may help overcome some of the Commission's concern that the winning bidder in a Vickrey auction may obtain a license for much less than its revealed willingness to pay. For instance, the winning bidder might pay the average of the first- and second-highest bids.

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6 For further discussion of this type of auction mechanism, see pages 11 and 12 of the comments by Bulow and Nalebuff as economic experts for Bell Atlantic.

C. Bidders Should be Able to Submit Combinatorial Bids in Simultaneous Auctions.

Based on the principle that the auction process itself should not hinder the aggregation of frequency bands or the combination of licenses for different trading areas when doing so creates economic value, we concluded in our comments that the Commission should adopt a combinatorial bidding procedure.

The desirability of combinatorial bidding was perhaps the most contentious issue among the economic experts. There are three sets of issues that have been raised and must be addressed: (1) the nature of the biases between individual and combinatorial bids inherent in any given procedure; (2) the specification of what combinations are acceptable; and (3) arguments about diversity.

1. Combinatorial bidding can be designed to strike a desirable balance in the auction competition between the bidders for combinatorial and individual licenses.

Several commentors have argued that any form of combinatorial bidding will be biased against the efficient allocation of spectrum to parties bidding for individual licenses. They supported this argument by providing examples in which there is a bias in the allocation of spectrum toward bidders seeking combinatorial licenses. These examples establish the potential bias in favor of combinatorial bidders for the specific auction institutions considered under the specific conditions assumed to hold. We believe, however, that these analyses are incomplete and, consequently, potentially misleading. There are two major points that must be kept in mind.

First, any choice of auction mechanism will affect the relative abilities of combinatorial and single-license bidders to obtain spectrum. Thus, while there may be biases against single-license bidders, there also can be biases against bidders seeking to put together combinations of licenses.

There are at least three obstacles that a firm attempting to aggregate licenses may face. One, the firm may be uncertain about the total cost of putting together a package of licenses and thus may fear getting into a situation in which it ends up paying more than its true economic value either for the whole combination of licenses or for some subset of the overall combination of licenses that it sought. Two, the firm may face strategic bidding by rival telecommunications providers who seek to gain competitive advantage by preempting the firm from putting together attractive packages of licenses. Finally, the firm may fear strategic bidding by rivals firms to facilitate hold out, whereby an auction participant bids more than its true economic value of using the spectrum itself in order to obtain the spectrum and then resell it to a bidder who places a higher value on its use.[7] The relative strengths and importance of

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[7] This problem is not unique to spectrum licensing. The obstacles faced by developers trying to put together parcels of land for a large real estate project long have been recognized. Parties holding small, but critical pieces of land may hold out for very high payments in an effort to extract some of the surplus created by aggregation. With wireless licenses, one might approach this problem by banning resale. We think that this approach would be ill advised on two grounds. First, as Milgrom and Wilson, and others, have noted, the resale market may play an extremely valuable role in correcting misallocations that occur in the initial auctioning

(Footnote Continued On Next Page)

these three potential impediments to the assembly of license combinations will depend on the auction institutions adopted.

In the appendix to our reply comments, we present a simple example that demonstrates how disallowing combinatorial bids can discourage efficient spectrum aggregation in some settings due to the first type of obstacle identified above. We illustrate how this impediment arises under the realistic assumption that each bidder is uncertain about the bidders' true economic valuations. Intuitively, the national bidder in the example considered may be reluctant to go after any one license individually because it does not know how much it will have to pay to win the other licenses and cannot be assured of obtaining the whole package at a reasonable cost.

It might appear that this problem could be solved by allowing the national bidder to withdraw its bid if it were about to win a single regional license at a price greater than its willingness to pay for that license alone. But a policy of allowing bid withdrawals raises a whole host of complexities: it can lead to cascading withdrawals by other bidders; it may necessitate re-running auctions; and it may make it impossible for a bidder to know the true status of its bids during the

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7 (Footnote Continued From Previous Page)

process or that arise as the result of other industry changes after the initial auctions. Moreover, even if resale were disallowed, parties might engage in hold up by obtaining licenses and then entering into partnerships or alliances with the firm trying to aggregate spectrum. Indeed, build-out requirements and the magnitude of foregone revenues might induce firms to get up their own networks up and running.

running of the auctions. Thus, we support the arguments of Bulow and Nalebuff and Milgrom and Wilson that bid withdrawals should not be allowed (and default should be heavily penalized), and we disagree with the apparent conclusion of McAfee. Once one chooses not to allow bid withdrawal, some form of combinatorial bidding can serve the valuable role of facilitating economically efficient license aggregation.

The examples in the Appendix are not intended to serve as a general analysis of the issues faced by the Commission. Rather, they illustrate some of the forces at play. And, perhaps more important, they point out the danger of drawing overly broad conclusions from examples of bias against single-license bidders, particularly when those examples are based on the unrealistic assumption that each bidder's willingness to pay for any given license or combination of licenses is known to all.

All of this is more than academic speculation. It is important that the Commission recognize the very real economic costs of strongly biasing the auction process against combinatorial bids. If geographic aggregations of licenses make economic sense, they will occur either during the initial auction of PCS spectrum or in the resale market. An auction process that is not biased against combinations is likely to reduce the transactions costs of aggregating licenses and accelerate the deployment of PCS. Moreover, the government may receive higher fees for PCS licenses. If, on the other hand, the auction is strongly biased against aggregation, efficient aggregation may occur after the auction, resources will be spent

on negotiating and acquiring licenses, and the deployment of PCS may be slowed. The history of the cellular industry is instructive on this point: Only now, more than a decade after granting licenses, are wide-area services that provide seamless roaming emerging at regional and national levels.

In addition to the loss of benefits to U.S. telecommunications users, a delay in the implementation of such services for PCS could cause a significant loss of potential competitive advantage to U.S.-based equipment manufacturers and PCS providers. As a matter of national economic policy, PCS and wireless communications will be one of the largest, fastest-growing markets in the world. Other nations, especially those in the European Community with its GSM standard, are hoping that early deployment can provide a "domestic platform" for gaining international competitiveness by moving down the learning curve and the scale economies curve. While we are not suggesting that the Commission should bias the auction in favor of national or regional licenses, we think it should not bias the process against such combinations.

A second major point to keep in mind is that some of the biases that have been identified in the comments are due to the specific auction mechanisms considered and not the concept of combinatorial bidding itself. Suppose there are 51 simultaneous English auctions for single-MTA licenses and a single round of sealed biding for a national license. Several commentors argued that each of the single-MTA auctions would see the price rise to the second-highest value placed upon the license by bidders in that auction, so that a national bidder

would be able profitably to outbid the single-MTA bidders as long as its true value exceeded the sum of the second-prices. Suppose, for the sake of argument, that these analyses are correct.[8] Since the efficient choice entails the comparison between the sum of highest single-MTA values and the highest national value, then there would be a bias in favor of the national bidder.

Suppose, however, that the Commission adopted the following procedure. The national-license sealed bidding would be the following special type of second-price auction. The party with the highest sealed bid would win the national license at a price equal to the second highest national bid only if that second highest bid exceeded the sum of the highest bids in each of the single-license auctions. Then the situation would be one in which a second price in the national auction would be compared to the sum of the second prices in the individual MTA auctions. This procedure might well favor the single-MTA bidders.

We are not, at this time, recommending that the Commission adopt this procedure.[9] Rather, our point is that corrections are available and the Commission must think through

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8 In Part B of the Appendix, we argue that the analyses of specific examples used by the economic experts to reach this conclusion are incomplete: There are equilibria for the parameter values considered by those experts in which there is no free rider problem.

9 This procedure implicitly compares second price against second price, but the social decision rule should be based on a comparison of the true economic values placed on the spectrum by the parties competing for the spectrum.

carefully the effects of a wider variety of auction mechanisms than have been considered in the comments that we have seen.

2. The Commission should specify a well-defined set of non-overlapping combinations for bidding.

One issue that arises if combinatorial bidding is allowed is whether to have preset combinations defined by the Commission or to permit bidders themselves to create combinations. We support having the Commission define preset combinations that do not overlap with one another. As long as there is no overlap of combinatorial bids and the smaller bidding areas fit neatly within a combination, the rule for choosing a winner is simple. Suppose, for example, that there is a national licenses and 51 individual MTA licenses. At the end of the bidding, the highest combinatorial bidder would be declared the winner if and only if its bid exceeded the sum of the highest bids in the 51 single-MTA auctions.

An alternative approach would be to allow bidders to create any combinatorial bids that they wish. In its comments, the NTIA supports this approach to the definition of combinatorial bids. While the overall thrust of the NTIA proposal (that the Commission should run simultaneous electronic auctions with iterative bidding and combinatorial bids) is close to our recommendations, we believe that this specific recommendation by the NTIA is flawed.

When each bidder is free to define the scope of its own combinatorial bid, the combinations may partially overlap, making it difficult to compare bids. Consider what would happen

if one participant put in a combinatorial bid for ten MTAs, while a second participant submitted a combinatorial bid for eight MTAs, four of which overlapped with the other combinatorial bid and four of which did not. How should the Commission determine which is the "higher" bid?

Any rule specified by the Commission for determining the winner would have severe shortcomings. A rule that attempted even to come close to making the efficient choice among such bids would have to be complex (e.g., a general Vickrey auction) to the point of creating confusion among potential bidders.[10] Any simple rule would run the risk of being seen as arbitrary and unfair.

We conclude that the Commission should define the sets of licenses for which combinatorial bids are allowable, and that the smaller licenses should neatly aggregate into the combined ones with no overlap across combinations. For the 30 MhZ block, the Commission should allow national combinatorial bidding in addition to bidding for the individual MTAs. MTA-level combinatorial bids should be allowed for spectrum blocks being auctioned at the BTA level (with a possible exception for blocks for which designated entities are given preferential treatment).

We also believe that regional combinatorial bids could be valuable. The central question is what the regions would look like. Because the RBOC regions were chosen based on community of interest and several other public interest

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10 General Vickrey auctions are discussed more fully in the comments submitted by Bulow and Nalebuff (pages 25-31) and by Milgrom and Wilson (pages 13-16).

criteria, there is a strong presumption that these are best regions. At the same time, we recognize that non-RBOC market participants are likely to feel that this unfairly disadvantages them.

3. Combinatorial bidding is fully consistent with the goal of diversity.

Some parties have argued against national licenses on the grounds that the attainment of diversity goals would be thwarted. These arguments are not based on sound economic reasoning. Moreover, the public interest is poorly served by a policy that undermines the creation of viable national competitors in the name of diversity.

Not surprisingly, AT&T and McCaw are among those arguing against national licenses on the grounds that diversity would be reduced. It is transparent that AT&T seeks to reduce the odds that the auction will produce an economically viable competitor to McCaw, now the nation's largest cellular carrier. While diversity is an important public policy objective, the Commission should also strive to promote the creation of economically viable competitors to existing cellular and wireline companies in the PCS auction process. One of the most important forms of diversity, after all, is the diversity of choice facing consumers of communications services. Consumers will not have this diversity of choice if PCS providers have service areas that are too fragmented to compete with firms such as McCaw that are offering near-nationwide services.

III. THERE IS A SIGNIFICANT PUBLIC INTEREST IN ALLOWING CELLULAR PROVIDERS TO PARTICIPATE IN THE PCS MARKET.

The Commission has imposed restrictions on the participation of cellular providers in PCS auctions. MCI would like to see even greater limitations placed on current cellular providers, while other parties would prefer to see existing restrictions relaxed. It is important to recognize that there are two separate issues that are getting mixed together in this debate. One issue is whether firms that are cellular operators today should be allowed to participate in the PCS marketplace. The other is whether firms should be allowed to be active in cellular and PCS simultaneously in the same geographic area.

With respect to the first issue, arguments that the public interest is served by banning (or severely restricting) participation by current cellular providers are mistaken. The design and construction of PCS networks present difficult problems of network engineering. Cellular providers have much of the expertise needed to get such systems up and running on a timely and cost-effective basis. It is socially wasteful not to let them make use of this know-how. Moreover, artificial restrictions on cellular carriers may harm their ability to compete effectively on a global scale. To date, U.S. cellular providers have been able to export their expertise. U.S. competitiveness could be hurt by undue restrictions on cellular companies.

Turning to the second issue, the Commission may want to limit simultaneous provision of cellular and PCS services by a single firm. Indeed, in order to achieve this end, the

Commission has placed restrictions on the cellular providers' ability to bid for PCS spectrum in those areas where they have a cellular license. This policy, however, may have the unintended effect of making it difficult for current cellular providers to obtain spectrum in areas where they currently have no cellular interest. This is the result of their not being able to pursue national licenses or even MTA licenses where there is partial overlap.

To prevent this inefficient outcome, the Commission should allow bidders to commit to divesting themselves of spectrum assets (either cellular or PCS) conditional on their winning one or more licenses that would otherwise result in overlap. Commission oversight could be used to ensure that the sale was made to a viable competitor.

In addition to allowing cellular providers to compete for broader geographic coverage, this approach allows cellular providers to move out of cellular (where necessary) and into PCS if they choose to do so. We would expect some cellular providers to make this choice in order to maximize the value created by the utilization of their design and construction skills. This expectation follows from the fact that there are more firms who could operate up-and-running cellular networks than there are firms that can design and construct new PCS networks.

IV. CONCLUSION

Economic analysis of PCS and other elements of the telecommunications marketplace supports the following conclusions:

1. The auctions for all of the PCS licenses should be run simultaneously.

2. Each PCS license should be allocated through the use of ascending bidding in an iterative process.

3. Bidders should be able to submit bids for pre-defined combinations of licenses.

4. If the Commission adopts sequential auctions, it should auction an entire group of licenses within a spectrum block before moving on to the next one, and it should randomize over the order in which geographic regions within a given block are auctioned.

5. The Commission should allow cellular providers to participate in PCS auctions subject to post-auction divestiture of overlapping wireless assets.

APPENDIX: NUMERICAL EXAMPLES OF SPECTRUM AUCTIONS

In this appendix we present examples that illustrate how disallowing combinatorial bids can discourage the efficient aggregation of spectrum in the presence of uncertainty about bidders' valuations. We also examine the free rider problem that may, in some circumstances, arise when firms seeking single-licenses bid against firms seeking combinatorial licenses.

A. When Uncertain About Rival Bidders' True Valuations, A Firm May be Reluctant to Attempt to Aggregate Licenses for Fear of Winning Licenses for which it has Overpaid.

Throughout the Appendix, we make the simplifying assumption that there are only two individual licenses up for auction, one for the western region and one for the eastern region. There are three bidders. In the initial example, their true economic values for the licenses are as shown in Table 1. Bidder W values only the western regional license, bidder E values only the eastern regional license, and bidder N positively values each regional license individually, but values a national license comprising both regions by more than the sum of the component values. Notice that it is efficient for the national bidder to obtain both regional licenses since 30 (the value of a national license to N) exceeds 29 (the sum of the maximal values placed on the individual licenses by W and E).

We make the realistic assumption that the national bidder is uncertain about the other bidders' willingness to pay for regional licenses. In particular, suppose that N's beliefs are those represented in Table 2 (although the true values are

those given in Table 1). For simplicity, we make the unrealistic assumption that the other two bidders know about N's beliefs as well as the information in Table 1. To highlight the role of uncertainty, we assume that resale is not allowed and there is no threat of hold out.

We will now demonstrate that the efficient aggregation of spectrum may not be realized in the absence of combinatorial bidding. To do this, we consider the likely outcomes under three different auction mechanisms.

1. Sequential Auctions without Combinatorial Bidding.

   Suppose that combinatorial bidding is disallowed and the regional licenses are auctioned sequentially, with the western license auctioned first. What should N do if the price reaches 14? N expects to win the license 50% percent of the time by bidding just over 14.[11] N believes that half of those times it will be able to obtain the eastern license at a cost of just over 15, but the other half of the time is expects to have to pay just over 17. Hence, the expected cost is just over 16. But the sum of bids just over 16 and 14, respectively, is greater than 30, so N would be unwilling to bid just over 14 to obtain the western license. Instead, W wins the western license, while E wins the eastern license. Spectrum is inefficiently misallocated to the relatively low-value regional services.

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11 Here, we are making use of the assumption that there is no possibility for other parties to engage in strategic hold out.

2. Simultaneous Auctions without Combinatorial Bidding. Suppose that the two regional licenses are auctioned simultaneously, but combinatorial bidding is disallowed. Consider what happens if the bidding proceeds to the point where W has the high bid of 14 for the west and E has the high bid of 15 for the east. What should N do? Suppose N bids just over 14 for the western license and just over 15 for the eastern license. Since the true values are those in Table 1, N would win both regional licenses at a cost of just over 29, which is less than its willingness to pay. But remember that N does not know which values are the true ones. N has to worry that its total cost of obtaining both licenses could be 31 or 33 (the sums of the higher values that N believes W and E may have for the regional licenses). N worries that it might win the western license at just over 14, but then find itself forced to bid all the way up to just over 17 to win the eastern license. The total would exceed N's willingness to pay for a national license. Comparing the expected gains and losses, N will neither bid just over 14 to obtain the western license nor just over 15 to win the eastern license.

We have shown that, without combinatorial bidding, a national bidder may be reluctant to go after any one license individually because it does not know how much it will have to pay to win the other licenses and cannot be assured of obtaining the whole package at a reasonable cost.

3. Simultaneous Auctions with Combinatorial Bidding.

With combinatorial bidding, a firm is assured that it does not get stuck buying an incomplete package that it does want. Thus, the firm should be willing to bid as high as its true economic value to obtain a national license. In this example, N should be willing to make a combinatorial bid of up to 30 to win the two regional licenses as a package. Thus, one would expect N to win a national license because W and E are collectively willing to pay at most 29 (= 14 + 15). As a result of the combinatorial bidding procedure, the initial auction process allocates spectrum to its highest value use.

In this example, we have assumed that N may overestimate, but never underestimate, the true economic values that the other bidders place on spectrum. Consider what would happen if W placed a true value of 14 on the western license and E placed a true value of 17 on the eastern license, while N continued to have the beliefs given by Table 2. Now, the efficient license allocation is for W to operate the western regional license and E to operate the eastern regional license: the national bidder's value of the combined licenses is 30, which is less than the sum of the maximal values placed on the individual licenses, 31.

The analysis presented above can readily be extended to demonstrate that, in the absence of combinatorial bidding, there are equilibria in which W and E are awarded the licenses. But what happens when combinatorial bidding is allowed? The

answer is that there are some equilibrium outcomes in which the regional licenses are efficiently allocated to W and E, and other equilibrium outcomes in which N inefficiently obtains a national license.

It is useful to explore the forces underlying this multiplicity of equilibria in a variant of this example that is more directly comparable with those presented by economic experts who argue that combinatorial bidding biases the outcome toward spectrum aggregation.

B. The Importance of the "Free-Rider Problem" Associated with Combinatorial Bidding Should not be Overstated.

In their comments, the economic experts of Nevada Bell/Pacific Bell and PacTel provide analyses of specific examples that are said to illustrate a bias in favor of combinatorial bidders. We use a modified version of the example just presented to illustrate a shortcoming of these analyses. Assume (as did the commentors whose analysis we are discussing) that each bidder knows the true economic valuations that all bidders place on the licenses and these values are given in Table 3. For these values, the efficient license allocation is for W to operate the western regional license and E to operate the eastern regional license.

Consider the effects in this example of combinatorial bidding with a set of simultaneous auctions. If one were to apply the analysis used by others to argue against combinatorial bidding, one would identify the following outcome as the most likely in this situation. Under the candidate outcome, W would bid just above 11 for the western license, E would bid just

above 15 for the eastern license, and N would win the national license by bidding just over 29.[12]

We disagree with the conclusion that this is the likely or most plausible outcome in this example. Why should E let the auction end at this point? In this example, there is no cost to raising its bid to 16 if it believes that N is going to obtain a national license anyway, and if raising its bid to 16 somehow allows E to obtain the eastern regional license, then it enjoys a surplus of 1 unit. W might now reason that it can win the western regional license by bidding just over 14 because that would put the sum of the two regional license leading bids above N's willingness to pay of 30. Under this outcome, the licenses would be efficiently allocated. Indeed, there is a continuum of equilibria in which W bids between just-over-13 and 14 for the western regional license, E bids between just-over-16 and 17 for the eastern regional license, and the sum of the two bids is just over 30. Under all of these equilibria, the licenses are efficiently allocated on a regional basis even when combinatorial bidding is allowed.

Of course, in reality, all parties face uncertainty about other parties' true economic values, as well as their own true economic values. Thus, we do not want to conclude from this analysis that there never can be a free rider problem. Rather, our point is that the free rider problem should not be overstated and the source of the problem is in need of more

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12 See the comments of McAfee, pages 13 and 14, and Milgrom and Wilson, pages 8-11, for analyses of similar examples along these lines.